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MUTUAL SUPPORT OF INTELLIGENT BUILDING COMPONENTS IN THE SCOPE OF LIGHTING CONTROL

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Summary. The purpose of the present article is to discuss the components of intelligent electric systems used in the building management systems for the lighting control and to present the methodology in the scope of their design using KNX/EIB system as an example. The role performed by KNX/EIB system, previously called EIB (European Installation Bus) among the intelligent systems is important, because this system combines the tasks of a conventional system and introduces many new functions enabling the control of individual systems in the building.

Key words: lighting, control, intelligent, designing, integration, system

INTRODUCTION

The electric energy becomes more and more important in contemporary modern society. Its ineffective use means that our capabilities are lost in 60%. More effective energy use not only could help to protect limited resources of mineral fuels but also contribute to the reduction of carbon dioxide emission. The effective energy use is particularly important at the time of global energy crisis [7, 8].

Owing to the improvement in the scope of building engineering techniques and modern architectonic solutions, also the electric system is subject to transformations. The idea of intelligent building engineering and so called intelligent systems has become popular and more present in our everyday life in recent years. Nowadays "an intelligent" house is not a luxury any more but becomes a more and more commonly applied solution.

The first electric systems in the buildings were equipped with conventional accessories i.e. fuses, sockets, circuit – breakers, cam switches, light fittings. However the further development in the scope of the conventional electrical systems is practically impossible. The works associated with the new systems are continued owing to continuous trend towards the improvement of the standard of contemporary buildings. The development of electronic engineering and computerization in many fields of our life are also reflected in the electric systems sector. New control and regulation systems are created by the manufacturers of the systems equipment introducing control engineering solutions into building management systems. Owing to their advanced development and complexity, it is necessary to find a new approach to the designing of these systems, power supply methods, as well as to the localization and elimination rate of potential disturbances.

The optimisation of energy consumption in the buildings should be based upon the energy use only in case of such necessity; the amount of energy to be used should be maintained on a reasonably low level and at the highest possible efficiency. The use of intelligent building system is favourable in this case [1, 6, 12, 13].

LIGHTING CONTROL

The lighting control systems [1, 4, 6] have been created and are widely applied as a result of necessity of electric energy saving as well as the need to create proper working conditions.

In order to generate the savings, the systems installed in the building should support each other ensuring so called systems integration. It is possible by integration of all individual systems by means a superior system i.e. the building management system – BMS. Thanks to impressive spectrum of products dedicated for the lighting control, measurement, regulation and management, KNX/EIB system can perform the most demanding tasks. This system often is applied as the basic system of BMS enabling wide automation of the illumination control in the building and energy saving e.g. by lighting turnoff in the rooms with detected lack of occupants (employees). The use of daylight in order to ensure the required illumination level is also important. The wireless control is also possible by means of this system. Its advantage consists in the possibility of monitoring of the objects being controlled from any location, simple and user friendly operation, easy installation, operation reliability and safety. The achievement of individual illumination levels in various rooms and application of lighting scenarios to be activated in accordance with activity performed in those rooms e.g. writing, party, TV watching or reading is also ensured in KNX/EIB system control.

The images transmission is possible in real time through the connection with video module. An Internet Gateway automatically informs about events and alarms by means of an e-mail. The connection with Internet Gateway is possible via LAN by means of browser and its known IP address or by means of an Internet Explorer and specialized service e.g. www.domoport.de [5, 9, 10].

The security procedures applied in case of remote controlling of an intelligent electric system are similar to those used in Internet banking. All pages are encoded (SSL protocol) and 3 – level authorization is used [2, 3, 11].

The Internet Gateway is applied in commercial applications e.g. in electrical engineering systems, heating, ventilation, air-conditioning and in residential houses; for instance to extend the possibilities of already existing systems, to ensure remote supervision over summer houses and remote supervision over all-year houses.

When designing an intelligent electric system, the designer should first of all adhere to relevant standards in the scope of electric systems. The designer of the building management system should thoroughly analyse the actual needs of the building and its users.

The lighting control belongs to the group of most popular functions of an intelligent building. The lighting in modern building is something more than only the basic requirement – because the lighting can perform an important role in the architectonic design and affect the energy performance of building except of the health, safety and the good feeling of its inhabitants.

The lighting control in KNX/EIB system is understood as: automatic turning on, turning off, dimming, brightening up or maintenance of constant illumination for the light sources. The lighting control can be also supplemented in the form of window roller blinds or shutters control additionally enabling proper adjustment of natural daylight illumination [3].

In comparison to the conventional system, the energy savings are possible in the building with KNX/EIB system thanks to lighting control. However, it is impossible to determine the level of these savings in a precise manner, because they depend on many factors:

In the houses equipped with KNX/EIB system, the extension of the lighting control system is possible in a manner enabling full use of the lighting functions as well as the support of other systems of the building, among others the window roller blinds or shutters control system.

Fig. 1. Lighting control opportunities in KNX/EIB system.

The product range offered by many companies being the members of KONNEX association of the manufacturers of KNX/EIB system devices, encompasses the electric apparatuses used in the indoor lighting automatic control engineering. For instance the following electric equipment is offered by ABB[1]:

- Lighting controllers used in order to maintain the constant illumination in the rooms dedicated for work and for rest of occupants. Thanks to the combination of natural and artificial light, maximum energy consumption savings is possible.
- The movement and occupancy sensors used for the monitoring of lighting and other electric energy receivers installed indoors and outdoors.
- Illumination sensors for measurement of lighting levels.
- Dimming actuators ensuring the control of lighting consisting of incandescent and halogen lamps. They enable the control of the degree of illumination in the buildings in an economic and universal manner.
- Regulators used in order to maintain the constant illumination level in the working environment area combining the natural and artificial light in order to achieve the maximum energy consumption savings.

The construction of the lighting control by means of KNX/EIB system encompasses also the local lighting regulation in the building rooms. The dimmers and individually controlled light fittings supporting the lighting sensors are used for this purpose.

An example illustrating the lighting control possibility by means of KNX/EIB system has been presented in Figure 1. All lamps in the building can be turned on and off in individual or in group mode (Fig. 2).

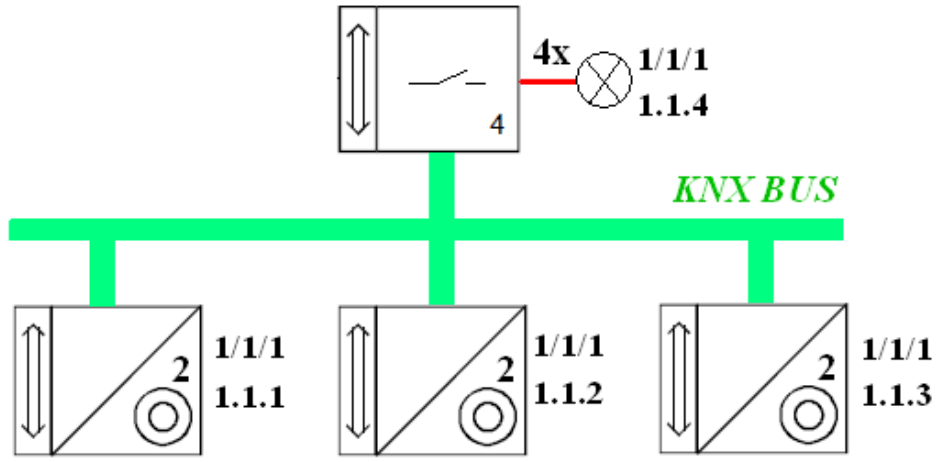

Fig. 2. Bidirectional connection in KNX control: four -channel actuator for lighting control is turned on by dual channel sensors.

A clock, movement sensors or infrared pilot (Fig. 3) can also be used. Therefore, it is possible to adapt the lighting to the needs of users. The illumination in the rooms does not have to be constant. Its level can be controlled by means of illumination sensors. It is very important for instance on the table or desktop for work where the value of illumination should be correspondingly high.

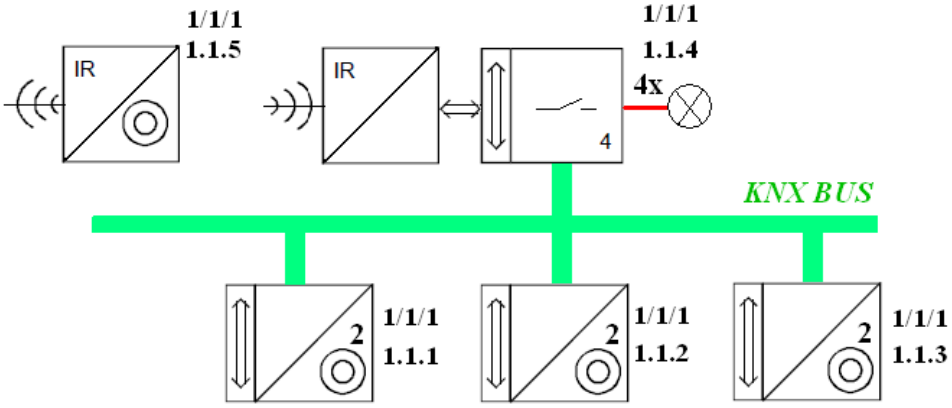

Fig. 3. Bidirectional connection in KNX control: four channel actuator for lighting control and IR control is turned on by dual channel sensors

The lighting control system is provided in the building in combination with other systems. Therefore, its analysis should be carried out against the background of the complex building management system and its relations with other systems e.g. air-conditioning, ventilation and heating system, etc. should be considered [3,4].

Therefore KNX/EIB system devices dedicated for the application in lighting system are supported by the devices provided for the purposes other than the control of lighting.

The role of the window roller blinds or shutters control is significant in the course of the lighting control. The roller blinds systems are used in the buildings in order to protect against sun lighting. If the illumination in the room is insufficient, any artificial lighting is unnecessary because the solution consisting in automatic shutter angle control vs. sun position is more favourable (Fig. 4).

Fig. 4. Shutter inclination angle control depending on sun position

The shutters are open in a manner ensuring the access to daylight without penetration of dazzling light into the room. Therefore the illumination control becomes a more efficient and economical solution. The integration of the shutter controller with the devices dedicated for the lighting system control has been illustrated in Figure 5.

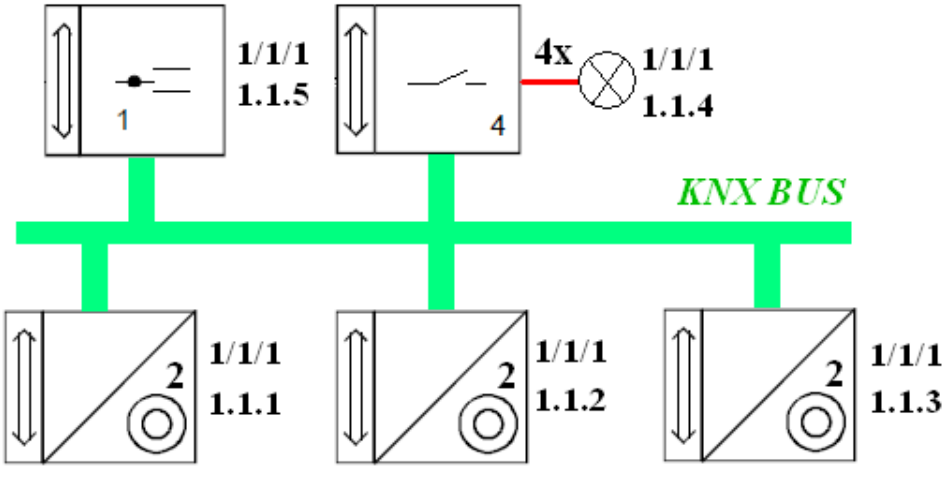

Fig. 5. Diagram of shutter inclination angle control depending on the sun's position

Another important method of the lighting regulation existing in KNX/EIB system and giving certain savings is the so called dimming. The dimming is possible in a manual mode i.e. a specified lamp is controlled individually by the user until anticipated illumination is achieved or

in automatic mode maintaining the constant illumination level in the room irrespective of varying daylight conditions.

The maintenance of the constant illumination level in the rooms with consideration of varying external conditions is an important element affecting the lighting control. The air conditioning units and illumination sensors which are installed in the rooms (Fig. 6) are used for this purpose.

Fig. 6. Principle of indoor artificial lighting control depending on varying natural light conditions [1]

An example can be presented as group of lamps situated in the closest distance from the windows; this group of lamps can be turned off during a bright day and other lamps can be dimmed to the required illumination level, depending on the amount of daylight. Therefore the energy is saved which would be used for the room lighting – wholly with artificial light. Moreover, in order to ensure the stable and comfortable conditions in the room, the lamps are dimmed or brightened up smoothly with long time constants; therefore the lighting regulation is physically invisible.

In order to enable the energy savings, PIR movement sensors are very often used in the lighting regulation circuits. Their task is to turn on the lighting in the rooms only if the human presence is detected. A turn on/ off single bit information is transmitted by the movement sensor to the bus. Certain savings of energy to be used for lighting will be possible as a result of introduction of such elements into control circuits.

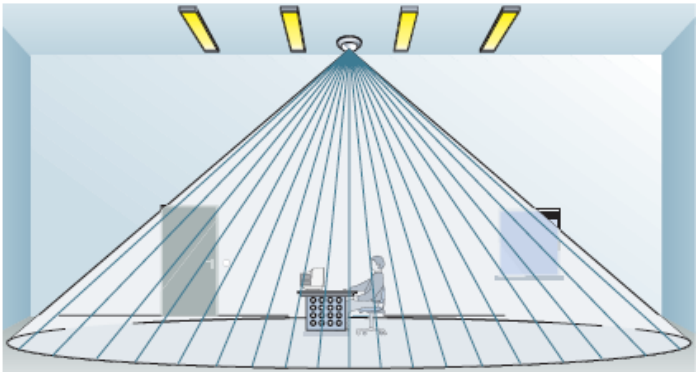

Fig. 7. Use of movement sensor detecting human occupancy in the room for lighting control [1]

The ordinary turning on or off of the circuits is the prevailing part of the lighting control. The real time clocks are often used for this purpose.

The central control mode is also possible by means of KNX/EIB system (Fig. 8). The double pole circuit-breaker with physical address 1.1.3 is dedicated for the control of an actuator with physical address 1.1.6 and simultaneously is used for the central control of both actuators in the considered circuit.

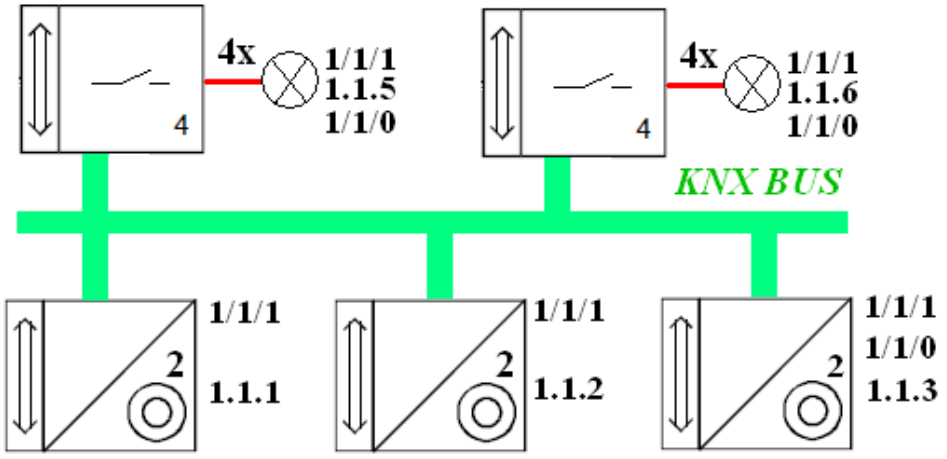

Fig. 8. Central control for lighting in KNX/EIB system

Using EIB system for the daylight and artificial light control, it is possible to save even ten percent of electric energy to be used for lighting. The lighting can be turned on in the whole building by means of EIB system and by means of only one pushbutton; e.g. with simultaneous dropping of external roller shutters.

The methods of the lighting control in the residential building presented above are used in order to ensure the comfort and to minimize the electric energy consumption. The consumption of electric energy for the lighting purposes in the buildings is significant; therefore significant savings are possible, through proper control.

CONCLUSIONS

The designer engaged in the designing of lighting systems in intelligent buildings should have the knowledge of the technical and legal issues associated with other types of systems. Many factors, among others: the quality and reliability, functionality, availability in the market, system costs, possibility of further integration with other systems as well as perspectives of development and competitiveness in the market. The correct integration of all building systems, basing upon detailed analysis of their functions is essential for a good design. On the basis of integration, the selection of devices and their correct parametrization is performed by the designer / integrator of an intelligent system. Owing to specific and unique features of each object, the reproduction of ready solutions by the designer would be a very risky approach without their critical evaluation and checking with respect to functionality in any case.

The conscious energy consumption is necessary to ensure the safety in future and leads to a more economical house. The real energy saving is commenced already in the building design phase. The energy savings achievable thanks to the lighting control depend on many factors. Therefore it is impossible to determine their level precisely without the functioning analysis of the relevant building system. It is possible in an approximated manner only.

The rational and responsible behaviours should be promoted, facilitated and strengthened in order to support the efficient energy use.

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WSPÓŁPRACA KOMPONENTÓW INTELIGENTNEGO BUDYNKU W STEROWANIU OŚWIETLENIEM

Streszczenie. W artykule omówiono komponenty inteligentnych instalacji elektrycznych wykorzystywane w systemach automatyki budynkowej do sterowania oświetleniem oraz metodykę projektowania tych instalacji na przykładzie systemu KNX/EIB. Ważne miejsce wśród systemów inteligentnych zajmuje system KNX/EIB, do niedawna znany pod nazwą EIB (Europejskiej Magistrali Instalacyjnej). Łączy on zadania tradycyjnej instalacji oraz wprowadza wiele nowych funkcjonalności umożliwiających sterowanie poszczególnymi systemami w budynku.

Słowa kluczowe: oświetlenie, sterowanie, inteligentny, projektowanie, integracja, instalacja